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How a Change in Brazil's Sugar Policies Would Affect the World Sugar Market

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By changing its policy, Brazil could increase its sugar exports greatly. The world price would decline, but Brazil's sugar revenues would increase.

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This paper -- a product of the International Trade Division, International Economics Department -- is part of a larger effort in PRE to understand the impact of changes in countries' trade policies on world commodity markets. Copies are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Audrey Kitson-Walters, room S7-053, extension 33712 (30 pages).

Although Brazil is the world's largest sugarcane producer, only one-third of the cane it grows is used to produce sugar; the rest is used to produce ethanol as fuel for automobiles. Still, Brazil is the world's fourth largest sugar producer. What would it mean for Brazil and for the world sugar market if Brazil were to shift largely away from ethanol to sugar production?

This question is of keen interest for the world sugar market because such a shift — although politically difficult — is possible. Brazil's system of controlling the sugarcane and sugar industries to ensure enough ethanol for domestic fuel needs is costly. With the border price of petroleum at $24 a barrel, for example, the shadow price of ethanol as a fuel substitute is about 4 to 5 cents a pound in sugar equivalent. (The world price of sugar is now 9 cents a pound.)

Borrell uses a nine-region trade model of the world sugar industry to study this question under both dynamic and stochastic simulations. Simulations were run on sustained increases in Brazilian sugar production of 0.5 million tons, 2 million tons, and 6 million tons. To examine the sensitivity of Brazil's influence on price at different phases of the world sugar price cycle, these sustained increases were simulated from two different start dates. Moreover, the model was run 60 times over the period 1985-2004, with different shocks representing random elements such as weather.

Borrell concludes that although Brazil could influence world sugar prices significantly in the short run, it could not influence them to its short- or long-term advantage by restricting production. Indeed, to the extent that Brazil could make world prices more stable by allowing its producers increased flexibility in production, removing existing production controls could provide not only substantial economic gains (in terms of increased exports to Brazil) but also more stable world prices. For other producers, there could be a tradeoff in terms of lower but more stable income.

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Table of Contents

I. INTRODUCTION

Brazil is by far the largest sugarcane producer, with output of well over 200 million tons of cane annually. However, only about one-third of the cane grown is used to produce sugar. The majority is used to produce ethanol--a substitute automobile fuel. Brazil is the fourth largest sugar producer after the EEC, India and the USSR. The vast quantities of cane produced potentially give Brazil an immense capacity to produce more sugar. If all cane grown were used to produce sugar, Brazilian sugar output would rise from around 8 million tons annually to over 20 million tons. Currently, around 105 million tons of sugar are produced worldwide each year.

A tight net of governmental controls and interventions has long been a feature of the Brazilian industry. They strictly limit the industry's ability to switch cane between ethanol and sugar production. Potentially, the economic gains for the Brazilian economy from diverting cane away from ethanol to sugar are great. With a border price of petroleum at around $24/barrel ($18/barrel for Saudi crude) the shadow price of ethanol as a fuel substitute, measured in sugar equivalents, is about 4-5¢/lb only. Compared to recent world sugar prices in the range 9-15¢/lb, the marginal opportunity cost of not switching is clear.

Brazil's ethanol program has been strongly promoted by government and has been highly visible. Politically, a radical reversal of policies on ethanol seems unlikely. Nevertheless, the economic arguments for switching at least some cane away from ethanol to sugar production are very persuasive.

Because Brazil is already a major exporter and given it has the sugarcane to nearly treble its sugar output, the impact of a change in Brazilian policies on the world price is of great interest. The purpose of this study was to estimate the potential impact of changes in Brazilian production on the world sugar market. Policy implications of the impact will also be discussed.

A nine-region trade model of the world sugar economy is used to study Brazil's impact on the market. The model is dynamic, allowing both short- and long-run impacts to be studied. The model also makes it possible to study Brazil's potential to affect the variability of the world price--sugar is the most volatile of all commodity markets.

II. CONSTRAINTS ON BRAZILIAN SUGAR PRODUCTION

Unconstrained market forces play little if any role in the allocation of resources in Brazilian sugarcane, sugar or ethanol industries. Through various interventions and controls, the Brazilian government indirectly determines the structure and behavior of these industries. Annual production quotas allocated to farms, mills and distilleries regulate the location, size and distribution of the sugarcane crop. Domestic sugarcane, sugar and ethanol prices are fixed and exports are controlled. Overall, intervention and controls isolate producers and consumers from changes in world market conditions. Changes in world sugar or fuel prices therefore have no direct effect on the production or consumption of sugarcane or its derivatives.

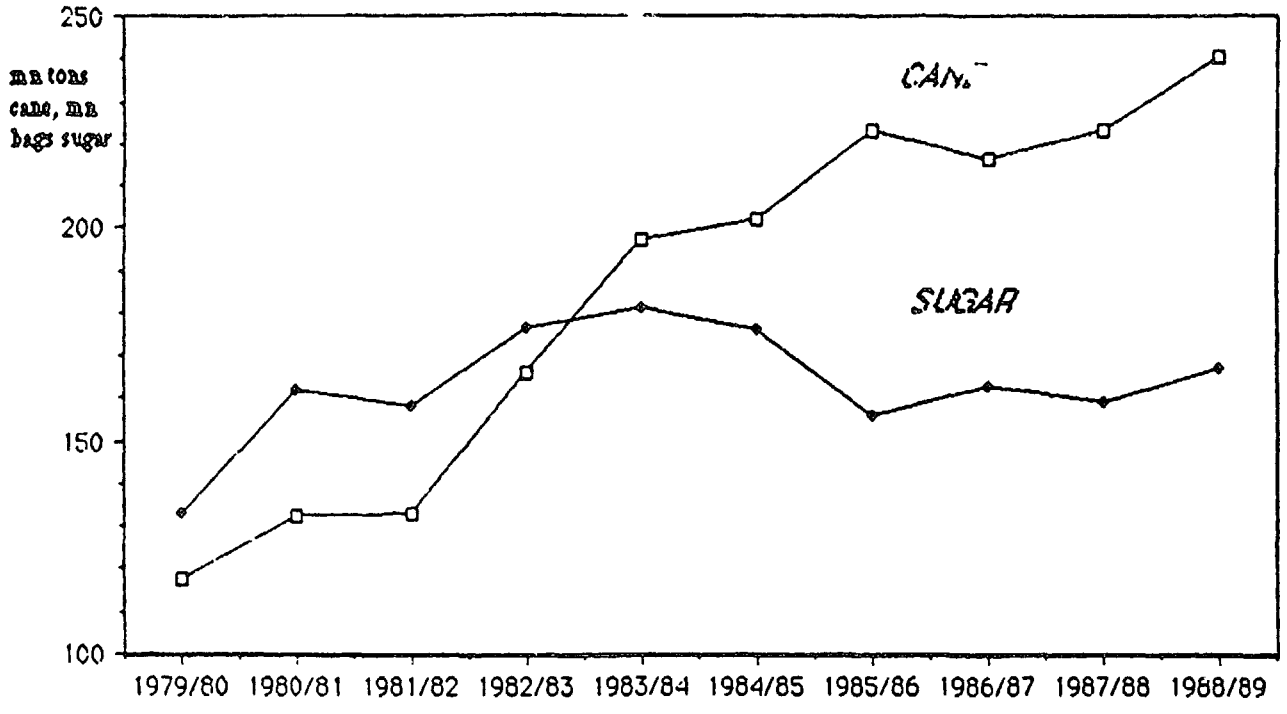
Sugarcane, sugar and ethanol prices for producers are fixed at high enough levels relative to costs to ensure all available production quotas are filled. By world standards, Brazilian sugarcane and sugar producers are very low cost. Ethanol production is not cost competitive with imported crude oil prices but ethanol prices to producers are set sufficiently high to ensure distilleries face incentives to fill their quotas. Also, concessional credit is provided for investment in distilleries. Quotas, however, are the main determinants of production. Any switching which occurs between the production of sugar and ethanol occurs as the direct result of changes in quotas only.

During the 1980s quota increases for ethanol far outpaced those for sugar. As seen in Figure 1, production of cane increased appreciably while sugar production was held reasonably steady--the increase in cane was used for

ethanol production. Policies favor the consumption of ethanol over other fuels and regular increases in supply have been necessary to meet the energy demands of the ever-enlarging fleet of ethanol-powered cars.

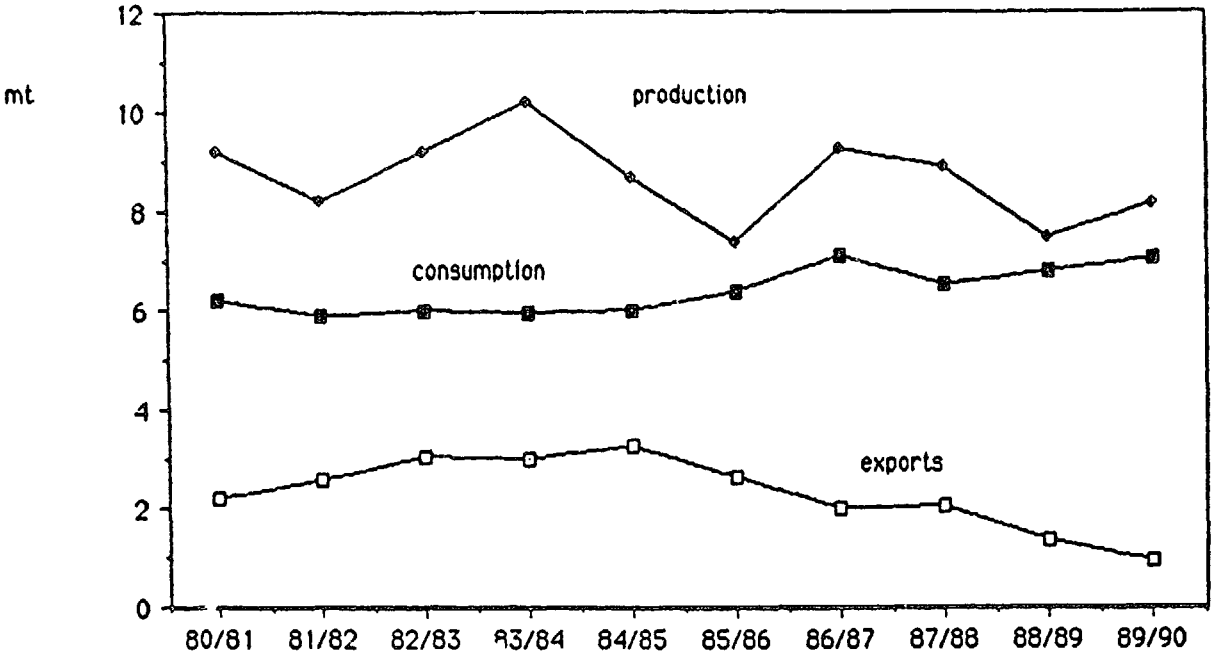
Until recently the retail price of ethanol was set at a substantial discount relative to the blended gasoline/ethanol price, and many cars are fully reliant on pure ethanol. It is very costly to convert ethanol-powered engines to gasoline. The ethanol fuel program has reduced Brazil's dependence on imported oil, but has made its economy highly dependent on the use of sugarcane for ethanol production. Each year the stock of cars running on pure ethanol is increasing. With total production controlled by government policies, large volumes of the 1989/90 cane crop have been diverted from sugar production to meet the rising ethanol demand. This has occurred despite the higher sugar prices and has caused Brazil's sugar exports to decline to a 25-year low--in fact they have been declining since 1984/85 (see Figure 2). The empirical evidence (see Wong, Sturgiss and Borrell, 1989) is that Brazil's capacity to switch cane between sugar and ethanol in response to even larger changes in crude oil and sugar prices is greatly limited under current policies.

Figure 1: CANE AND SUGAR PRODUCTION IN BRAZIL



Source: World Bank, Brazil Agriculture Operations Division, Latin America and the Caribbean Region.

Figure 2: PRODUCTION CONSUMPTION AND EXPORTS OF BRAZILIAN SUGAR



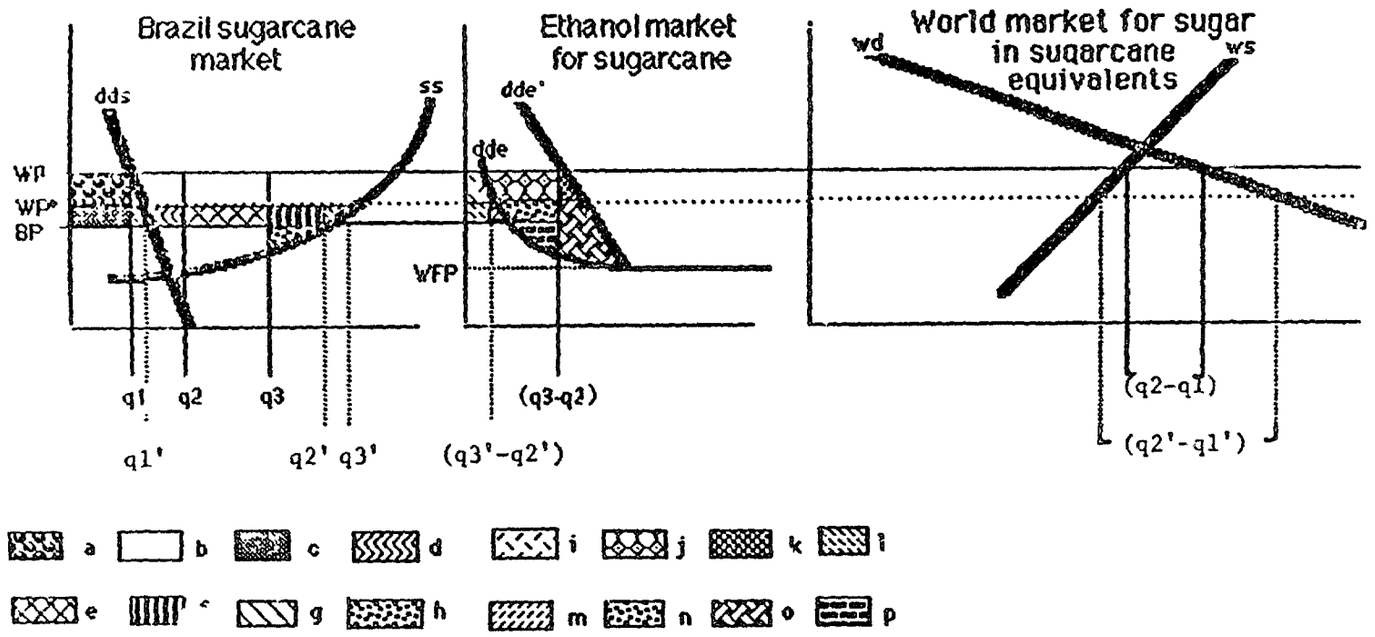
Source: F.O. Licht's.

III. A MODEL OF THE BRAZILIAN SUGARCANE, SUGAR AND ETHANOL INDUSTRY POLICIES

The workings of the various instruments included in Brazil's cane/sugar/ethanol program are illustrated in Figure 3. The demand for sugarcane is a derived demand arising from the demand for sugar (domestic and international) and the demand for ethanol. The derived demand arising from Brazilian sugar consumers is represented in the left panel of the graph (dds). The demand for sugarcane for the production of ethanol is the derived demand after taking into account all policies favoring the consumption of ethanol over other fuels and is represented in the middle panel (dde'). In the absence of such policies the derived demand for sugarcane emanating from ethanol demand would be highly inelastic over a small range and then become perfectly elastic reflecting the world price of other fuels. This is also represented in the middle panel (dde). In the right-hand panel the rest-of-the-world demand and supply of sugar are represented in sugarcane equivalent terms.

The total supply of Brazilian sugarcane, if the market were undistorted, is represented in the left panel (ss). For the purposes of illustration it is assumed that the Brazilian market for sugar provides the primary demand for sugarcane and consumes q1. Excess supplies of sugar are exported to the rest of the world. In sugarcane equivalent terms, q2-q1 is depicted as being exported from the left panel and imported in the right-hand panel, and the world market is in equilibrium at the world price (WP--expressed in sugarcane equivalent terms). Excess supplies are also made available to the ethanol industry and market, as shown in the middle panel. (q3-q2) of sugarcane is transferred to the ethanol market for sugarcane.

FIGURE 3: REPRESENTATION OF BRAZILIAN POLICIES



The supply of sugarcane to sugar mills is limited by production quotas on sugar and delivery quotas on sugarcane itself--equivalent to q2. Once the quotas to the sugar mills are filled, excess supplies of cane are used to fill the delivery quotas to ethanol distilleries and the production quotas placed on distilleries themselves (q3-q2). Irrespective of whether cane is delivered to distilleries or mills, growers receive the government-fixed cane price (BP). As depicted, the cane price is set sufficiently high to ensure all quotas (in total the sugarcane quota is q3) are filled. It is assumed that prices for sugar and ethanol to consumers are set in a manner that enables the domestic markets to clear. In reality, prices and quota levels are not always consistent with the market clearing at government-fixed prices. This opens the opportunity for black marketeering. For the sake of analysis it is also assumed that domestic sugar prices are set in line with world prices, though in fact the world price fluctuates widely and domestic prices are fixed, being sometimes above and sometimes below the world price.

The economic effects of the policies can be illustrated by comparing the present situation to that which would prevail under competitive free trade. This is also represented in Figure 3. The fixed cane price, production and delivery quotas, and policies favoring ethanol consumption would no longer apply. Demand for ethanol would change in line with that represented by curve dde instead of dde'. Unless there was a substantial change in relative world sugar/fuel prices (compared to the current situation in the world markets for these commodities), the change in demand for cane from the ethanol sector would lead to a significant quantity of sugarcane being diverted from ethanol to sugar production in the long term [(q3-q2)-(q3'-q2')]. In the short term,

ethanol may not be represented by the opportunity cost of alternative fuels because the cost of converting ethanol-powered engines to alternative fuels is high. Nonetheless, in th long term, greater quantities of sugar would be produced for the world market (not only because of switching from ethanol to sugar but also because (q2'-q3') extra sugar would be produced as a result of dropping the production controls) causing the world price to decline from WP to WP*; (q2'-q1') would be exported to the world market. The extent of the world price decline would principally depend on the nature of supply and demand in all other trading countries (that is, by the slopes of the demand and supply curves in the right-hand panel).

If Brazil's impact on the world sugar market is not large and the world price does not decline below BP, the production and income of Brazilian sugarcane growers could increase in a free trade situation. This situation is depicted in Figure 3. Growers' welfare would increase by c+d+e+f+g+h. Economic rents represented by a+c, which are currently being received by either the government or others in the marketing chain, would be lost. As indicated, growers would receive c. Consumers would receive a. Consumers would also gain b. Fuel users would gain i+j+k+n+o+p, while others in the ethanol marketing chain currently gaining rents equal to i+j+l+m would lose them. However, the government would save on subsidies currently being paid to ethanol producers (not shown in the graph). Overall, the gains to the Brazilian economy would be at least b+d+e+f+g+h+k+o+p.

If Brazil's impact on the world sugar market is large and the world price declines significantly below BP, it is conceivable that the production

and income of Brazilian sugarcane growers could decline in a free trade situation. Nonetheless, the Brazilian economy is still likely to benefit due to the reduction in fuel costs. Ultimately, the benefits of switching cane from ethanol to sugar production depend on Brazil's impact on the world price. This, in turn, depends on the elasticity of demand for Brazilian sugar.

IV. BRAZIL'S IMPACT ON THE WORLD SUGAR PRICE

Government intervention in domestic sugar markets is widespread and typically insulates producers and consumers from changes in the world price. World production and consumption are, therefore, relatively unresponsive to changes in the world price, at least in the short term. Only stock demand is relatively responsive to changes in the world price, and then only at certain times (as discussed below).

Because consumption and production are largely unresponsive to changes in the world price, increases in Brazil's production may need to be matched (mostly) by increased quantities of stocks demanded in other countries in the short run. The world price will adjust to induce stockholders to willingly hold such stocks. Changes in stock demand may, therefore, be important in understanding the price effects of increases in Brazilian supply.

When stock levels are high, security of supply is well established and the value of stocks is low. Accordingly, the world price is low. A small change in stock levels either way will not change the implied level of security much. So, any additional supply from Brazil could be held as stocks without much change in the value of total stocks, implying little change in the world price. If, however, stock levels are very low then the existing stocks have very high value (world price is high). A small change in supplies at this time will have a relatively large impact on security. An increase in supplies from Brazil would quickly increase security and therefore the world price might fall rapidly. In the short run, therefore, Brazil's influence on

the world price could be greater when the world price is high compared to when it is low because of the response of stocks demand.

Although slowly, policy makers do respond to changes in the world sugar price, causing some response in production and consumption over the longer term. The world sugar price is notoriously volatile and cyclical. And at times, changes in policy can be large. Therefore, over the longer term, other countries may make adjustments to help accommodate the increased production from Brazil, thus lessening Brazil's impact.

Volatility in world agricultural commodity markets generally gives rise to forces which compel farmers to form coalitions and to demand political action to address farm problems caused by price instability and risk. The incentives for consumer groups (and perhaps taxpayers) to respond politically to volatile prices are different from those of farmers. Uneven political pressures from producers, consumers and taxpayers are postulated by Wong, Sturgiss and Borrell (1989) to give rise to policy intervention which consistently favors one group over another in domestic sugar markets. Usually this involves protection to farmer groups. Policy responses to changes in the world price are therefore postulated to be asymmetric. Production quotas and producer (and consumer) prices are usually increased one or two years after a world price rise or peak, but are decreased only slowly in response to price falls.

In the past, long periods of surplus production have followed price booms. When prices fall due to a surge in production, producers have a strong

incentive to see their fixed investments protected. Given that governments may have, or appeared to have, encouraged their industries to expand in the first place, politically it is difficult to lower protection--despite the rising economic and financial costs of such policies. The continuing protection of the enlarged industries causes another sustained period of depressed prices. Indeed, the expectation of increased protection resulting from low prices may be an incentive for producers to overexpand when given the opportunity to do so due to a policy change.

Only after long periods of depressed prices is action likely to be taken to decrease levels of government support. With low world prices the costs of export rebates and government stockholding increase considerably. Further, the costs to consumers increase. Eventually, these mounting costs lead to changes in the domestic price level or to changes in other instruments such as production controls, but these changes occur slowly and only after sustained periods of low prices.

In the long term, the asymmetry of policy and production to changes in the world price in many countries may hold important implications for Brazil. Contrary to the short-run impact, Brazilian expansion will have less effect on the long-run average world price if it occurs when the world price is rising than if it is falling. Such results have been obtained in analyzing Australia's long-term impact on the world market (Sturgiss, Connell and Tobler, 1990). Expansions which ease supply shortfalls during a period of rising prices will reduce the extent of the peak in the price cycle. The incentives for policy changes in other countries, particularly high-cost

countries which otherwise encourage large expansions, will be lessened. Taking account of the phase of the world price cycle when expansion begins may, therefore, be important to understanding Brazil's potential to affect the world market.

Changes in the world market could alter Brazil's future impact on the world price. There could be changes in the responsiveness of world demand and supply to movements in the world price. A move towards less regulation through the current GATT round of multilateral trade negotiations would expose more producers and consumers to the world price. The emergence of close substitutes for sugar, such as aspartame or crystalline high fructose would also make consumers somewhat more responsive to changes in the sugar price. Such increased responsiveness of producers and consumers would make the effects of a Brazilian expansion on the world price less than might currently be the case.

V. EMPIRICAL ESTIMATES OF BRAZIL'S INFLUENCE ON THE WORLD PRICE

The world sugar market model of Wong, et al (1989) was used to estimate Brazil's potential impact on the world market price. Sustained increases in Brazilian sugar production of 0.5 million tons, 2 million tons and 6 million tons were simulated and compared with a baseline run in which production was assumed to increase in a fashion similar to what has occurred in the past. To examine the sensitivity of Brazil's influence on price at different phases of the world price cycle, sustained increases were simulated from two different start dates.

Although sustained output increases provide a basis on which to estimate Brazil's influence on the market, in reality if producers were exposed to world prices they would have incentives to respond to and anticipate price changes. Accordingly, production would vary to some extent with fluctuations in the world price. The potential for Brazilian producers to respond to the world price in an unregulated environment cannot be easily determined. However, to provide some representation of the potential effects of producer flexibility, a procedure similar to that used by Wong, et al was used. 1/

1/ The procedure used in this study varies from that used by Wong et al in the way the price expectation variable is specified. In Wong et al the deterministic world price is used as the expected price, and the assumed forecasting error is the difference between the deterministic and stochastic world price. The forecasting error is therefore explained by random shocks which producers cannot anticipate. This technique is computationally complex because both deterministic and stochastic versions of the model must be solved simultaneously. The computer time taken to run the model more than doubles compared to when just one version of the

For each simulation, the model was run 60 times over the period 1985 to 2004 with different shocks representing random elements affecting production (such as weather) being applied in each year and in each simulation. The results presented are the averages of the 60 simulations for each year. They therefore represent the average impact under a wide range of potential market conditions. Accordingly, the results should be regarded as illustrative of the potential impact under a variety of market conditions rather than forecast effects based on current market conditions. The forward simulations are performed based on market information up until 1985. The simulations therefore do not take into account the recent, and most unexpected, decline in Brazilian exports. The prices presented for the baseline simulation are not World Bank forecasts. They do, however, represent the type of price behavior that can generally be expected in the world market--although to some extent the true variability of price is masked by the averaging of the 60 simulations.

The estimated effects of sustained increases in production and exports from 1985 onwards are presented in Table 1. Over the entire 20-year period simulated, the 0.5 million ton increase in Brazilian production translates into an average 8.3% increase in exports. Because the increase is

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model is run. To overcome this difficulty a simpler procedure was used which achieves a similar result. The expected world price was set equal to the stochastic (or actual model-generated) world price plus a random error with a mean of zero and a standard deviation equal to that generated for each year from all 60 stochastic runs for the baseline. The assumed producer forecasting error was therefore assumed to be random with a distribution reflecting the expected distribution of prices in any particular year, given the typical sorts of random shocks in production and their effect on the uncertainty of prices. The standard forecasting error is over 40% of the long-run average world price, and is therefore quite large.

Table 1 Effects on World Price of Sustained Expansions from 1985 Onwards

Year	Simulated World Price USc/lb #	Change in World Price: 8.3% increase in exports *		32.6% increase in exports *		96.1% increase in exports *	
		%	Elasticity of Export Demand	%	Elasticity of Export Demand	%	Elasticity of Export Demand
1985	7.3	-4.4	-3.1	-16.4	-3.3	-40.2	-4.0
1986	6.1	-5.7	-2.5	-20.6	-2.7	-47.9	-3.3
1987	8.3	-6.2	-1.7	-22.6	-1.8	-52.7	-2.2
1988	9.0	-5.5	-1.8	-21.1	-1.9	-52.0	-2.2
1989	14.5	-5.5	-1.6	-20.7	-1.7	-54.0	-1.8
1990	14.1	-3.5	-2.7	-16.3	-2.3	-48.2	-2.3
1991	11.8	-2.5	-3.7	-12.7	-3.0	-42.3	-2.6
1992	15.2	-2.6	-3.1	-11.2	-2.9	-38.2	-2.5
1993	26.6	-2.6	-3.0	-10.4	-3.3	-36.0	-2.5
1994	22.4	-1.8	-4.6	-6.7	-4.9	-24.6	-4.0
1995	13.7	-0.7	-11.6	-2.2	-11.2	-10.8	-9.0
1996	11.9	-0.8	-9.4	-4.2	-7.1	-13.7	-6.5
1997	13.0	-1.5	-4.9	-7.7	-3.8	-23.1	-3.8
1998	14.0	-2.1	-3.7	-9.3	-3.3	-26.4	-3.5
1999	13.6	-2.2	-3.4	-8.8	-3.4	-27.0	-3.3
2000	12.9	-2.3	-3.3	-9.0	-3.4	-26.0	-3.4
2001	18.6	-2.1	-3.1	-8.1	-3.2	-25.8	-3.0
2002	20.6	-1.4	-4.9	-6.3	-4.4	-22.8	-3.6
2003	17.3	-1.7	-4.0	-4.6	-6.0	-16.8	-4.9
2004	15.4	-0.6	-10.7	-3.2	-8.2	-13.6	-5.8
Average	14.3	-2.4	-3.5	-9.8	-3.3	-30.1	-3.2

#: Baseline average of 60 stochastic simulations in 1984 dollar terms.

*: Average increase across all simulations and all years.

constant over the period, it is a declining percentage of total exports through time--exports are simulated to grow through time irrespective of the exogenous increase. Similarly, the 2 million ton and 6 million ton increases translate into 32.6% and 96.1% average increases in Brazilian exports.

Based on the simulation results, the elasticity of Brazilian export demand over the projections period is estimated at between -2.5 and -3.2, implying that each 1% increase in Brazilian exports would lower the world price by between 0.29% and 0.31% (i.e., the reciprocals of the estimated elasticities) on average over a long period. 2/ Brazil is therefore estimated to indeed be influential in affecting the world price, but its influence is estimated to be insufficient to mean that Brazil could increase total revenue by restricting production. For this to occur, the elasticity would have to be greater than or equal to -1.0.

The impacts of the sustained increases on the world price are seen to vary through time about a declining trend. In part, the declining trend is explained by the growth in world consumption through time. It is also explained by the adjustments which Brazil's expansion induces in other countries. The greatest impact occurs 3 to 5 years after the expansion. The delayed impact occurs because the simulated increase begins in a period of low world prices when stocks are already at a high level. As explained earlier, when stocks are high small changes in them do not much affect the implied security of supply and so prices change less than when stock levels are low. Nonetheless, because production and consumption worldwide are so unresponsive

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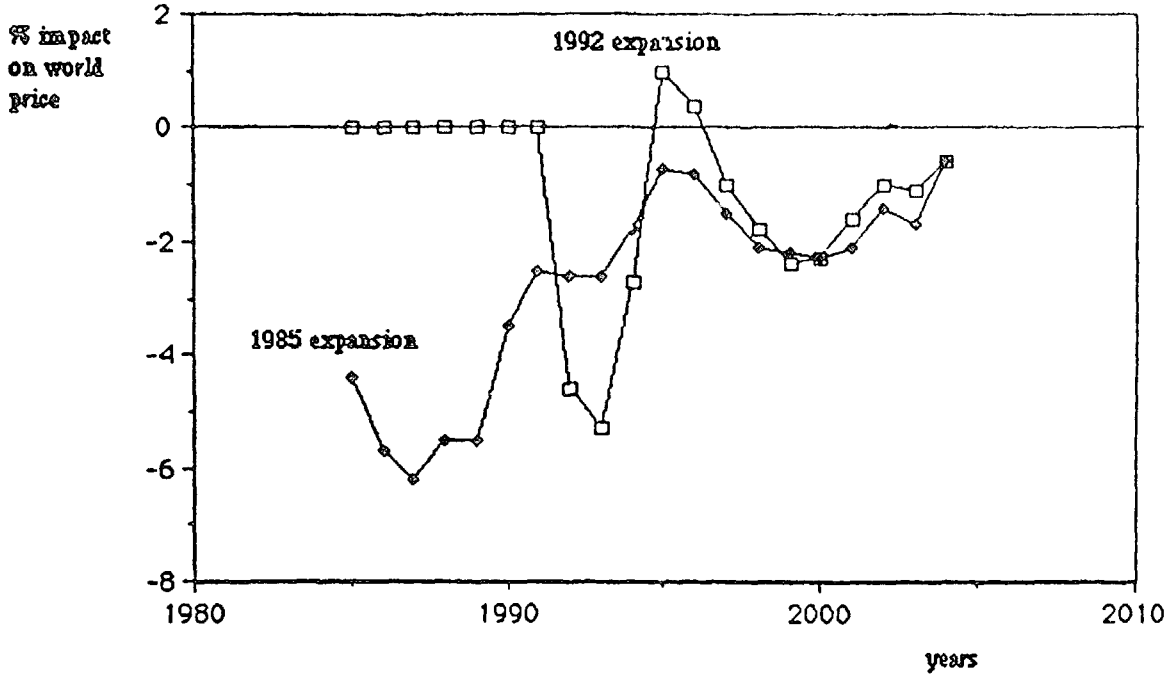
2/ The transformation from price elasticities to price impact can be made under certain conditions--see, for example, Houck (1965).

to changes in the world price in the short term, increased exports by Brazil during a period of low prices cause an increase in world stocks generally. This prolongs the period of depressed prices, having a relatively large negative effect during a period when prices first start to increase.

Brazil's increases have their least effect on the world price in the period immediately following a boom. This is due to two behavioral characteristics incorporated in the model. First, is the fact that lower prices during a boom period reduce the incentives for changes in policies which, in the past, have led to large increases in production worldwide. Reduced production elsewhere in the world mitigates the effects of Brazil's expansion. Second, is the effect on stocks referred to above.

The fact that Brazil's influence on the world price is lower during periods of high prices and immediately after them raises questions about the timing of expansions. In Figure 4, the impact on the world price of sustained 0.5 million ton increases starting in 1985 or 1992 (the beginning of a boom period) are compared. The initial impact is less for the 1992 start date than for the 1985 start date. Moreover, although beginning the output increase in the run-up to a boom is more influential in reducing very high prices than during a depressed phase, virtually throughout the remainder of the period the impact on price from the 1992 start date is less. Indeed, in the period following the boom, prices in this simulation actually increase due to the fact that other countries are not encouraged to expand as dramatically in response to the boom as they do in the other simulation. The elasticity of export demand in the 1992-start simulation is estimated at 4.4 over the 13 years to 2004, implying that a 1% increase in exports would lower the world price by 0.23%, compared to around 0.3% when the increase starts in 1985.

Figure 4: Comparison of effect on price of sustained increases in 1985 vs 1992



As stated earlier, sustained Brazilian output increases may not be realistic if producers are free to respond to the variability in the world price. As well as increasing production and exports to a greater extent when prices are high, producers would tend to reduce production as prices fall. Thus, world prices would be less variable in this more realistic world.

Without a detailed analysis, it is not possible to determine the flexibility of producers to respond to the world price. However, to provide some representation of the potential effects, it was assumed producers could respond directly to expected world prices to produce an additional quantity of sugar. It was assumed that when expected world prices rose above US¢10/lb, producers would progressively increase production up to a maximum additional quantity of 2.5% of world production at an expected price of US¢25/lb. The flexible component of production was added to the non-flexible component.

For illustrative purposes, three forms of price expectations were assumed--model-consistent expectations, perfect foresight, and naive expectations. Under model-consistent expectations, producers are assumed to have knowledge of all the information embodied in the model and to form their expectations of price in the same fashion as the model solves for price. However, because of random factors producers will make price forecasting errors. Their forecasting errors are assumed to be normally distributed with a mean of zero and a standard deviation equal to the standard deviation of prices for each year generated by the 60 stochastic runs of the model--which ranges from US¢2.7/lb to US¢8.5/lb (also see footnote 1).

The other forms of expectations were chosen as extreme alternatives. Under perfect foresight, producers are assumed to make no forecasting error, while under naive expectations producers are assumed to expect that next year's price will not be different from the current price. Perfect foresight provides an upper bound on the possible effects of expectations on production flexibility, while the naive expectations assumption provides a lower bound.

The potential price impacts of allowing producer flexibility in supply are presented in Table 2. The results under the assumption of perfect foresight suggest that if producers are able to anticipate prices exactly, increasing production and exports to a certain extent can raise prices in some instances (1995-2000 in Table 2) and cause the long-term impact on price (-0.07% for each 1% increase in exports) to be considerably less than when one-off, sustained increases are introduced. Even allowing for quite large forecast errors (equal to more than 40% of the average world price under model-consistent expectations), similar, though slightly less pronounced, impacts are simulated. The counter cyclical nature of producers' response to the world price under model-consistent expectations tends to make price less variable, as seen by substantial reductions in the coefficient of variation (0.46 to 0.392). Even under naive expectations there is some reduction in the coefficient of variation. Under naive expectations the average negative impact on the world price is, however, similar to that observed when sustained increases are simulated (-0.36). The world price impacts of flexible production under the assumptions about price expectations are shown in Figure 5.

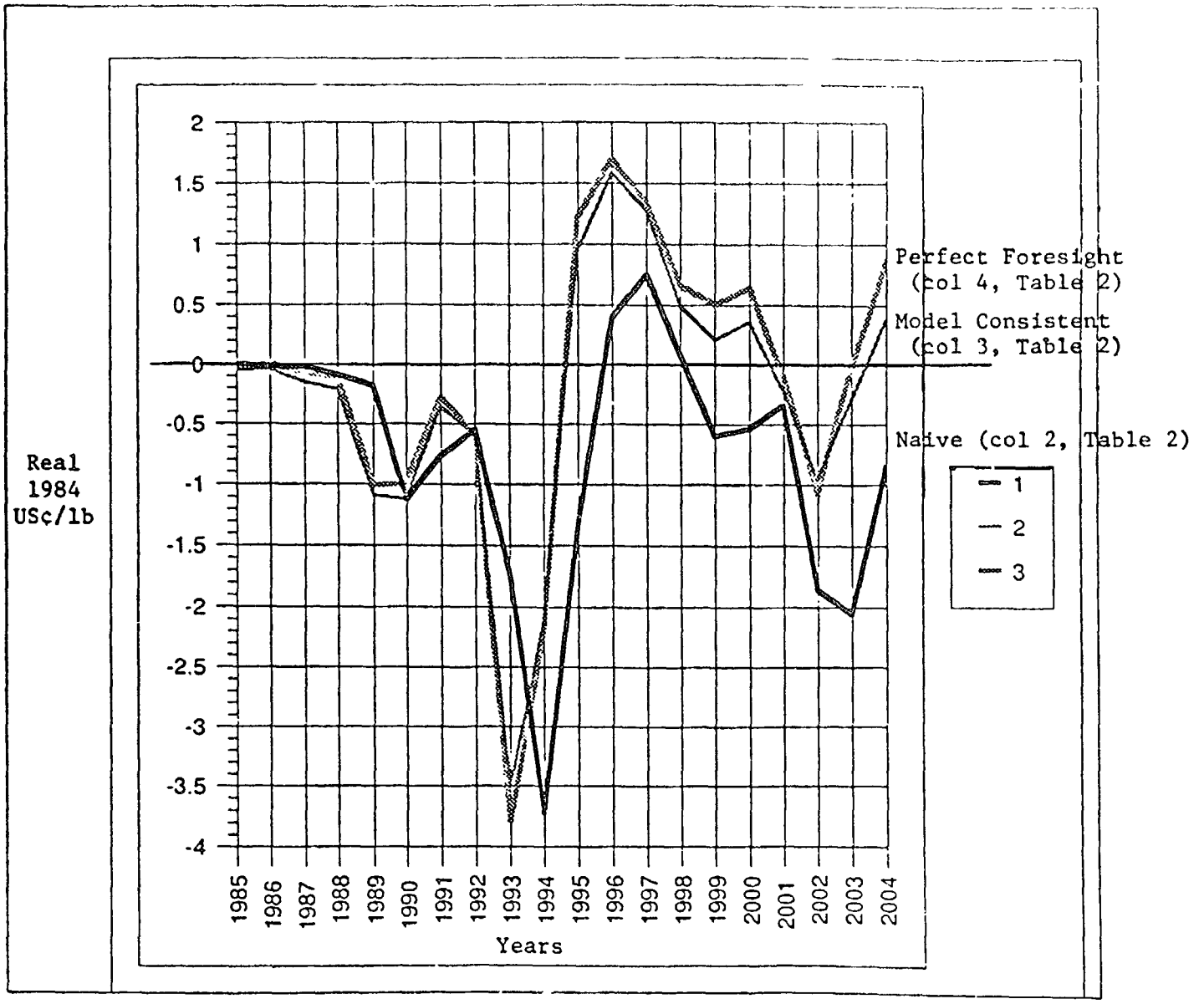
Table 2: Impact on World Price with Flexible Production (1984 US¢/lb)

Year	Baseline	Naive Expectations	Model Consistent Expectations	Perfect Foresight	Model Consistent 7.5-25 US¢/lb 2.5% Limit	Model Consistent 7.5-25 US¢/lb 5.0% Limit
1985	7.3	7.3 (0.0)	7.2 (-0.09)	7.3 (-0.03)	7.2 (-0.13)	7.1 (-0.23)
1986	6.1	6.1 (-0.02)	6.0 (-0.04)	6.1 (0.0)	6.0 (-0.09)	5.9 (-0.16)
1987	8.3	8.3 (-0.02)	8.1 (-0.15)	8.2 (-0.08)	8.0 (-0.25)	7.8 (-0.44)
1988	9.0	8.9 (-0.09)	8.7 (-0.21)	8.8 (-0.11)	8.6 (-0.36)	8.3 (-0.62)
1989	14.5	14.3 (-0.18)	13.4 (-1.09)	13.5 (-1.01)	13.2 (-1.31)	12.3 (-2.17)
1990	14.1	13.0 (-1.13)	13.0 (-1.13)	13.1 (-1.0)	12.8 (-1.34)	11.9 (-2.22)
1991	11.8	11.0 (-0.77)	11.5 (-0.36)	11.5 (-0.28)	11.3 (-0.54)	10.8 (-1.01)
1992	15.2	14.6 (-0.55)	14.6 (-0.59)	14.6 (-0.61)	14.4 (-0.76)	13.7 (-1.49)
1993	26.6	24.8 (-1.72)	23.1 (-3.5)	22.8 (-3.79)	23.0 (-3.53)	20.1 (-6.5)
1994	22.4	18.6 (-3.72)	20.2 (-2.11)	20.2 (-2.2)	20.2 (-2.15)	18.2 (-4.12)
1995	13.7	12.4 (-1.33)	14.6 (0.94)	14.9 (1.22)	14.4 (0.74)	14.4 (0.73)
1996	11.9	12.3 (0.39)	13.5 (1.58)	13.6 (1.69)	13.3 (1.34)	13.7 (1.78)
1997	13.0	13.8 (0.75)	14.3 (1.27)	14.4 (1.33)	14.0 (0.98)	14.1 (1.06)
1998	14.0	14.1 (0.08)	14.5 (0.49)	14.7 (0.66)	14.3 (0.24)	13.9 (-0.15)
1999	13.6	13.0 (-0.06)	13.8 (0.21)	14.1 (0.5)	13.5 (-0.03)	13.1 (-0.49)
2000	12.9	12.3 (-0.54)	13.2 (0.36)	13.5 (0.64)	13.0 (0.14)	12.7 (-0.18)
2001	18.6	18.3 (-0.34)	18.4 (-0.22)	18.5 (-0.1)	18.2 (-0.44)	17.0 (-1.56)
2002	20.6	18.8 (-1.86)	19.7 (-0.96)	19.6 (-1.07)	19.5 (-1.13)	18.0 (-2.67)
2003	17.3	15.2 (-2.06)	17.0 (-0.29)	17.2 (-0.02)	16.8 (-0.44)	15.9 (-1.33)
2004	15.4	14.6 (-0.85)	15.8 (0.38)	16.3 (0.86)	15.6 (0.16)	15.2 (-0.27)
Average	14.3	13.6 (-0.7)	14.0 (-0.3)	14.1 (-0.2)	13.9 (-0.4)	13.2 (-1.1)
Coeff. Var	0.466	0.429	0.392	0.382	0.397	0.357
Average % Impact Per 1% Increase in Exports		-0.36	-0.11	-0.07	-0.16	-0.21
Average % Increase in Exports		14.1	17.1	16.5	19.9	36.2
Average Elasticity of Export Demand		-2.77	-8.82	-14.15	-6.35	-4.72

Note: ( ) is change in US¢/lb (1984 dollars) compared to the baseline.

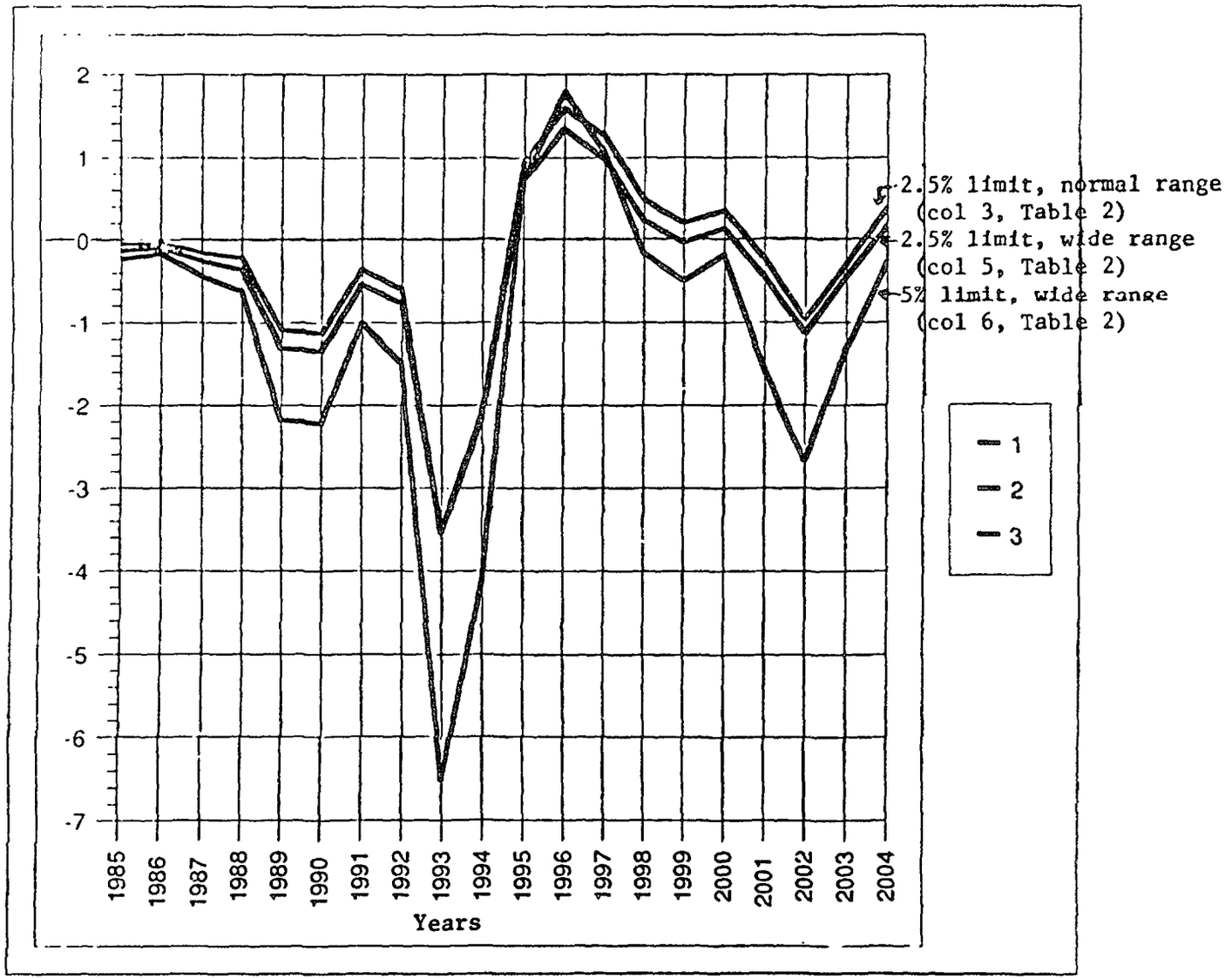
Source: World Bank, et al.
October 10, 1990

Figure 5: Impact on World Price with Flexible Production under Alternative Assumptions about Price Expectations



The average negative impact is also sensitive to the amount of flexible production assumed and to the price range over which flexible production is assumed to take place. In Table 2 and Figure 6 the effects of changing both the amount and the range are demonstrated. When the range is changed from 10-15¢/lb to 7.5-25¢/lb (7.5¢/lb is more in line with the sugar price at which sugar starts to become clearly more profitable than ethanol), the elasticity of export demand under model-consistent expectations changes from -8.82 to -6.35--and the increase in exports over the baseline run changes from +17.1% to +19.9%. When the maximum allowable amount of flexible production is doubled from 2.5% of world production to 5% (over the price range 7.5-25¢/lb), the estimated elasticity changes from -6.35 to -4.72. The increase in exports over the baseline changes from +19.9% to +36.2%. Compared to the baseline, the coefficient of variation in world prices is reduced by about 22%.

Figure 6: Impact on World Price With Flexible Production Under Model Consistent Expectations and Alternative Assumptions About the Range and Extent of Producer Responsiveness



VI. CONCLUSIONS

Although facing political difficulties in attempting to switch sugarcane away from the production of ethanol to sugar production and exports, Brazil potentially could achieve large economic gains from doing so. However, because of the vast quantities of sugarcane which could be switched to sugar production, the impact this might have on the world price for sugar could have a bearing on the economics of reforming the sugarcane, ethanol and sugar industries in Brazil.

Results presented in this paper suggest that changes in Brazil's sugar production have a reasonably large impact on world sugar prices in the short term. Nonetheless, its influence is not estimated to be great enough, either in the short term or long term, to enable Brazil to increase total revenue by restricting production (through the continued use of quotas). From the results it appears that the long-term impact that Brazilian expansion would have on the world price is sensitive to the types of policies Brazil adopts. Expansions of exports occurring as the result of sustained increases in quotas would have a larger relative negative impact on the world price than if the same long-term percentage increase were achieved by leaving producers free to respond to world prices (i.e., they adjust their production and exports in response to expected prices).

There are general reasons for believing that Brazil's long-term impact on price could be even less than estimated here. Orcutt (1950) discusses a number of reasons why econometric estimates of price elasticities

in international trade may be underestimated, which implies that a country's potential impact on world prices from changes in supply would be overestimated. Some of Orcutt's reasons may be valid with respect to the estimates in this paper. Further, as reviewed earlier, if structural changes in the world market make the rest of the world's producers and consumers more responsive to the world price in the future, Brazil's impact on the world price from changes in its exports will tend to be less than estimated.

Based on these findings it seems reasonable to conclude that although Brazil appears to have the potential to influence world sugar prices to some degree in the short term, it is nonetheless unable to influence them to its short- or long-term advantage by restricting production. Indeed, to the extent that the results presented suggest the possibility that Brazil could introduce an element of stability to world prices by allowing its producers increased flexibility in production, removing existing production controls could provide not only substantial economic gains in terms of increased exports to Brazil but also more stable world prices. For other producers, there could be a trade-off in terms of lower but more stable incomes.

References

Houck, J.P. (1965), "The relationship of direct price flexibilities to direct price elasticities," Journal of Farm Economics, 47, 789-93.

Orcutt, G.H. (1950), "Measurement of the price elasticities in international trade," The Review of Economics and Statistics, XXXII (2), 117-31.

Sturgiss, R., Connell, P. and Tobler, P. (1990), "Australia's influence on world sugar prices," Agriculture and Resource Quarterly, 2(1), 47-55

Wong, G., Sturgiss, R. and Borrell, B. (1989), The Economic Consequences of International Sugar Trade Reform, ABARE Discussion Paper 89.7, AGPS, Canberra.

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